

What is claimed is:

1. An optical antireflection film formed on a substrate formed from a synthetic resin, comprising: a first film formed on a surface of the substrate, the first film having a predetermined thickness and a refractive index substantially equal to a refractive index of the substrate; a second film formed on a surface of the first film, the second film having a predetermined thickness and a refractive index assuming a value falling within a range from 1.48 to 1.62 and comprising a material same as or different from a material forming the first film; and a multi-layered film formed on a surface of the second film, the multi-layered film having an antireflection characteristic.

2. The optical antireflection film in accordance with claim 1, wherein the first and second films each comprise a silicon oxide.

3. The optical antireflection film in accordance with claim 1, wherein the substrate is formed from an acrylic resin.

4. The optical antireflection film in accordance with claim 1, wherein the first film is a product obtained by a vacuum deposition method utilizing resistance heating.

5. The optical antireflection film in accordance with claim 1, wherein the multi-layered film comprises films stacked in a manner that adjacent ones of the films have respective refractive indexes that are different from each other while the films have respective refractive indexes that alternately and relatively assume high/low values.

6. The optical antireflection film in accordance with claim 5, wherein the multi-layered film has a third film as a layer next to an outermost layer which is situated most remotely from the second film, the third film having a refractive index assuming a value falling within a range from 2.2 to 2.4.

7. The optical antireflection film in accordance with claim 6, wherein the third film comprises one selected from the group consisting of TiO_2 , Ti_2O_3 , Ti_3O_5 , Ta_2O_5 , ZrO_2 , Nb_2O_5 , and a mixture of TiO_2 and ZrO_2 , as a major component thereof.

8. The optical antireflection film in accordance with claim 6, wherein the third film is obtainable by a process in which a film forming apparatus comprising a vacuum chamber and a bias supply electrode disposed within the vacuum chamber is employed and which comprises the steps of: placing the substrate on the bias supply electrode; evaporating a film

forming material within the vacuum chamber; supplying a high-frequency voltage to the bias supply electrode serving as one electrode to generate plasma within the vacuum chamber; and applying the bias supply electrode with a bias voltage having a frequency of not less than 20 KHz and not more than 2.45 GHz and varying in a wave form.

9. The optical antireflection film in accordance with claim 8, wherein the bias voltage has a negative mean value and a positive maximum value.

10. The optical antireflection film in accordance with claim 6, wherein the third film is obtainable by a process in which a film forming apparatus comprising a vacuum chamber and an ion beam generating structure for generating an ion beam for use in film formation is employed and which comprises the steps of: placing the substrate within the vacuum chamber; causing the ion beam generating structure to generate the ion beam; and depositing a film forming material on a surface of the substrate by utilizing the ion beam within the vacuum chamber.

11. The optical antireflection film in accordance with claim 10, wherein the ion beam generating structure is an ion gun, while the step of depositing the film forming material comprises the steps of: irradiating the film forming

material with the ion beam generated by the ion gun to evaporate the film forming material; and depositing the film forming material thus evaporated on the surface of the substrate.

12. The optical antireflection film in accordance with claim 6, wherein the third film is obtainable by a process in which a film forming apparatus comprising a vacuum chamber, a plasma generating structure for generating plasma to be supplied into the vacuum chamber, and a bias supply electrode disposed within the vacuum chamber is employed and which comprises the steps of: placing the substrate on the bias supply electrode; causing the plasma generating structure to generate plasma thereby to generate an electron beam comprising electrons present in the plasma and guiding the electron beam into the vacuum chamber; irradiating a film forming material with the electron beam to evaporate the film forming material; generating plasma within the vacuum chamber by the electron beam; and applying the bias supply electrode with a bias voltage to cause the film forming material evaporated to deposit on a surface of the substrate.

13. The optical antireflection film in accordance with claim 12, wherein the plasma generating structure is a plasma gun.

14. The optical antireflection film in accordance with claim 1, wherein the multi-layered film comprises stacked three layers comprising an outer layer film situated most remotely from the second film, an inner layer film situated most closely to the second film, and an intermediate layer film situated intermediate between the outer layer film and the inner layer film,

) the outer layer film having a refractive index that is lowest of refractive indexes of the respective films forming the three layers, the intermediate layer film having a refractive index that is highest of the refractive indexes of the respective films forming the three layers, the inner layer film having a refractive index that assumes a medium value between the refractive index of the outer layer film and that of the intermediate layer film.

) 15. The optical antireflection film in accordance with claim 14, wherein the outer layer film comprises magnesium fluoride (MgF_2) as a major component thereof.

16. The optical antireflection film in accordance with claim 14, wherein the outer layer film is obtainable by a process in which a film forming apparatus comprising a vacuum chamber and a bias supply electrode disposed within the vacuum chamber is employed and which comprises the steps of: placing the substrate on the bias supply electrode; evaporating a film

forming material within the vacuum chamber; supplying a high-frequency voltage to the bias supply electrode serving as one electrode to generate plasma within the vacuum chamber; and applying the bias supply electrode with a bias voltage having a negative mean value and a positive maximum value and a frequency of not less than 20 KHz and not more than 2.45 GHz and varying in a wave form.

17. The optical antireflection film in accordance with claim 14, wherein the outer layer film is obtainable by a process in which a film forming apparatus comprising a vacuum chamber, a plasma generating structure for generating plasma to be supplied into the vacuum chamber, and a bias supply electrode disposed within the vacuum chamber is employed and which comprises the steps of: placing the substrate on the bias supply electrode; causing the plasma generating structure to generate plasma thereby to generate an electron beam comprising electrons present in the plasma and guiding the electron beam into the vacuum chamber; irradiating a film forming material with the electron beam to evaporate the film forming material; generating plasma within the vacuum chamber by the electron beam; and applying the bias supply electrode with a bias voltage having a negative mean value and a positive maximum value to cause the film forming material evaporated to deposit on a surface of the substrate.

18. A process for forming an optical antireflection film on a substrate formed from a synthetic resin, comprising the steps of:

forming a first film to a predetermined thickness on a surface of the substrate by a vacuum deposition method utilizing resistance heating, the first film having a refractive index substantially equal to a refractive index of the substrate;

) forming a second film to a predetermined thickness on a surface of the first film by a vacuum deposition method utilizing resistance heating, the second film having a refractive index assuming a value falling within a range from 1.48 to 1.62 and comprising a material same as or different from a material forming the first film; and

forming a multi-layered film having an antireflection characteristic on a surface of the second film.

) 19. The process in accordance with claim 18, wherein the first and second films each comprise a silicon oxide as a major component thereof.

20. The process in accordance with claim 18, wherein the step of forming the multi-layered film comprises the step of stacking films on the surface of the second film in a manner that adjacent ones of the films have respective refractive indexes that are different from each other and

alternately and relatively assume high/low values,

the step of stacking the films comprising the step of forming a third film as a layer next to an outermost layer which is situated most remotely from the substrate, the third film comprising one film forming material selected from the group consisting of TiO_2 , Ti_2O_3 , Ti_3O_5 , Ta_2O_5 , ZrO_2 , Nb_2O_5 , and a mixture of TiO_2 and ZrO_2 , as a major component thereof.

21. The process in accordance with claim 20, wherein in the step of forming the third film, a film forming apparatus comprising a vacuum chamber and a bias supply electrode disposed within the vacuum chamber is employed, and the step of forming the third film comprises the steps of: placing the substrate on the bias supply electrode; evaporating one film forming material selected from said group within the vacuum chamber; supplying a high-frequency voltage to the bias supply electrode serving as one electrode to generate plasma within the vacuum chamber; and applying the bias supply electrode with a bias voltage having a frequency of not less than 20 KHz and not more than 2.45 GHz and varying in a wave form.

22. The process in accordance with claim 21, wherein in the step of applying the bias supply electrode with a bias voltage, the bias voltage has a negative mean value and a positive maximum value.

23. The process in accordance with claim 20, wherein in the step of forming the third film, a film forming apparatus comprising a vacuum chamber and an ion gun for generating an ion beam to irradiate a film forming material placed within the vacuum chamber with the ion beam is employed, and the step of forming the third film comprises the steps of: placing the substrate within the vacuum chamber; generating the ion beam by the ion gun and irradiating one film forming material selected from said group with the ion beam thus generated to evaporate the film forming material; and depositing the film forming material thus evaporated on a surface of the substrate.

24. The process in accordance with claim 20, wherein in the step of forming the third film, a film forming apparatus comprising a vacuum chamber, a plasma gun for generating plasma to be supplied into the vacuum chamber, and a bias supply electrode disposed within the vacuum chamber is employed, and the step of forming the third film comprises the steps of: placing the substrate on the bias supply electrode; causing the plasma gun to generate plasma thereby to generate an electron beam comprising electrons present in the plasma and guiding the electron beam into the vacuum chamber; irradiating one film forming material selected from said group with the electron beam thus generated to evaporate the film

forming material; generating plasma within the vacuum chamber by the electron beam; and applying the bias supply electrode with a bias voltage to cause the film forming material evaporated to deposit on a surface of the substrate.

25. The process in accordance with claim 18, wherein the step of forming the multi-layered film comprises the steps of: forming an inner layer film situated most closely to the second film; forming an intermediate layer film on the inner layer film; and forming an outer layer film situated most remotely from the second film, the outer layer film having a refractive index that is lowest of refractive indexes of the respective films forming the three layers, the intermediate layer film having a refractive index that is highest of the refractive indexes of the respective films forming the three layers, the inner layer film having a refractive index assuming a medium value between the refractive index of the outer layer film and that of the intermediate layer film,

the step of forming the outer layer film is the step of forming a film comprising magnesium fluoride as a major component thereof.

26. The process in accordance with claim 25, wherein the step of forming the outer layer film comprising magnesium fluoride as a major component thereof employs a film forming apparatus comprising a vacuum chamber and a bias supply

electrode disposed within the vacuum chamber, and comprises the steps of: placing the substrate on the bias supply electrode; evaporating magnesium fluoride as a film forming material within the vacuum chamber; supplying a high-frequency voltage to the bias supply electrode serving as one electrode to generate plasma within the vacuum chamber; and applying the bias supply electrode with a bias voltage having a negative mean value and a positive maximum value and a frequency of not less than 20 KHz and not more than 2.45 GHz and varying in a wave form.

27. The process in accordance with claim 25, wherein the step of forming the outer layer film comprising magnesium fluoride as a major component thereof employs a film forming apparatus comprising a vacuum chamber, a plasma gun for generating plasma to be supplied into the vacuum chamber, and a bias supply electrode disposed within the vacuum chamber, and comprises the steps of: placing the substrate on the bias supply electrode; causing the plasma gun to generate plasma thereby to generate an electron beam comprising electrons present in the plasma and guiding the electron beam into the vacuum chamber; irradiating magnesium fluoride as a film forming material with the electron beam to evaporate the magnesium fluoride within the vacuum chamber; generating plasma within the vacuum chamber by the electron beam; and applying the bias supply electrode with a bias voltage having

a negative mean value and a positive maximum value to cause the film forming material evaporated to deposit on a surface of the substrate.